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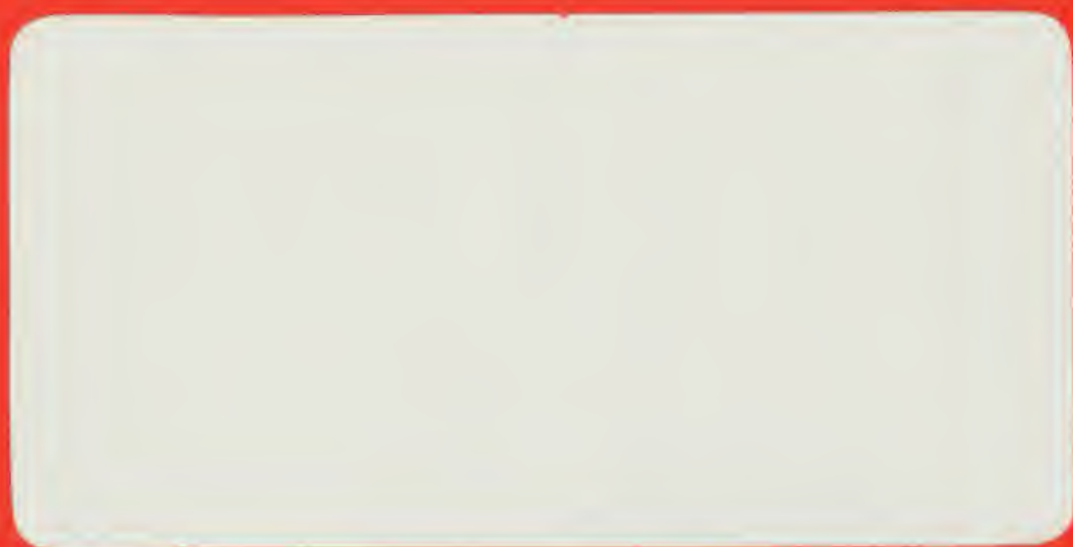
Faculty Working Papers

AREA, TIME, CENTRALITY, AND THE VALUE OF
URBAN LAND

Peter F. Colwell, Associate Professor of
Finance, and C. F. Sirmans, Assistant
Professor of Finance

#471

College of Commerce and Business Administration
University of Illinois at Urbana-Champaign



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Summary:

While a substantial body of literature exists on the determinants of urban land values, little work has been done on the influence of lot area. This is because value has generally been assumed to be proportional to area. This paper takes the point of view that a non-proportional value-area function may persist as a result of many factors including development costs, market imperfections, and regulatory constraints. It is hypothesized that value first increases at an increasing rate and then at a decreasing rate as area increases. This function gives rise to the potential for plottage and plattage, the value increment from assembling and subdividing land, respectively. Using a sample of land sales from Champaign, Illinois and two different models, this paper is able to confirm the hypothesis regarding the value-area function and, in addition, to confirm more conventional hypotheses regarding the impact of centrality and time on the value of urban land.

1. The first part of the report
describes the general situation
of the country in 1950.
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The third part describes the
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4. The fourth part of the report
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Area, Time, Centrality and the Value of Urban Land

1. Introduction

While a substantial body of literature exists on the determinants of urban land values, little work has been done on the influence of size or area.¹ Urban land economists have implicitly hypothesized that land value initially increases at an increasing rate and then increases at a decreasing rate as lot size or area increases.² However, no empirical work has come to our attention which tests this hypothesis. Most of the empirical research has hypothesized a proportional relationship since the dependent variable has been the value per unit of area with area excluded as an explanatory variable.³

The purpose of this paper is to examine this neglected aspect of urban land economics. The hypothesized relationship between value and lot area gives rise to the potential for plottage and plattage, the increment in value which comes from the assembly and the subdivision of land, respectively. Section 2 develops the hypotheses to be tested; Section 3 presents the model and the estimates of the model's parameters which serve to test the hypotheses; finally, Section 4 summarizes and discusses the implications of the results.

2. Hypotheses

Plottage is a well-known term for the additional value which is obtained by assembling two or more contiguous lots. If plottage exists, the value of the whole is greater than the sum of the values of the parts. Suppose that two lots of size L_1 , as shown in Figure 1, are assembled. Suppose further that the true value-area relationship is V in Figure 1.

The ratio of value to lot area of each is the slope of the ray out of the origin labeled n_1 . Thus the total value for the two lots is V_1 if they remain unassembled. Assembled the value becomes V_2 . The difference between V_2 and V_1 is plottage.

Plattage may be defined as the additional value which is obtained by dividing a lot into two or more smaller lots. In this case, the value of the sum of the parts is greater than the value of the whole. Plattage may exist in the same market as plottage--only over a different range of lot areas. This is so if the true value-area relationship looks something like V in Figure 2.

Suppose that three lots of equal area are made from a lot with L_2 area as shown in Figure 2. For each of these three lots, the ratio of value to area is the slope of ray n_2 . Thus the sum of the values of the three lots is V_3 while the value of the larger lot is V_4 . The difference between V_3 and V_4 is plattage, the additional value which accrues from dividing a lot of L_2 area into three equal parts.

In order to test the hypothesis of plottage and plattage, other factors must be held constant. Location, particularly centrality, has been shown to be a key determinant of urban land value. It is generally assumed, and will be here, that land value is a negative exponential function of distance from the center of the city.⁴ That is, value declines at a decreasing rate with increasing distance from the center. For example, value declines more between zero and one mile than between one and two miles.

The time of sale is another important determinant of land value. It is assumed in this study that land value is an increasing exponential function

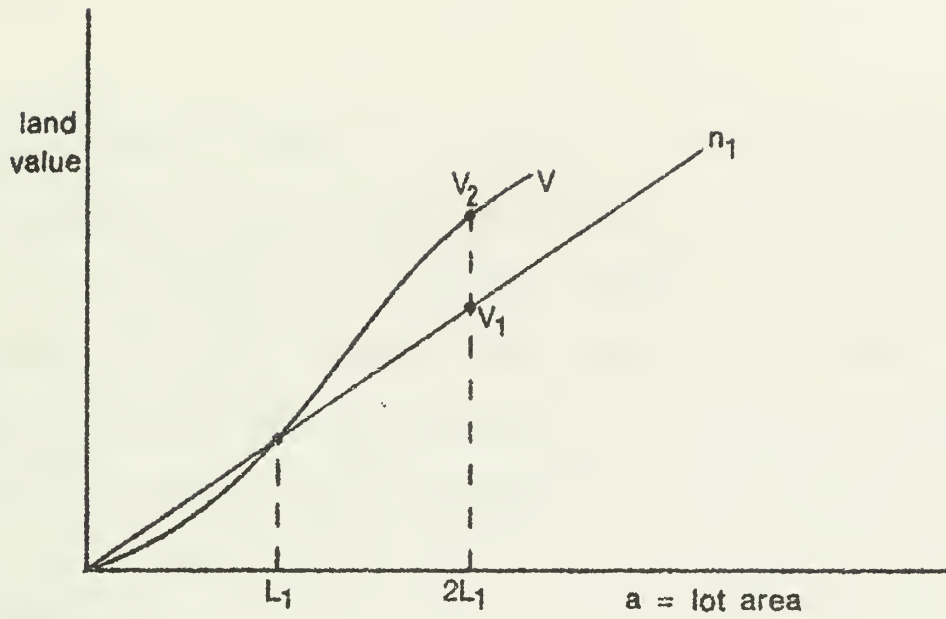


Figure 1

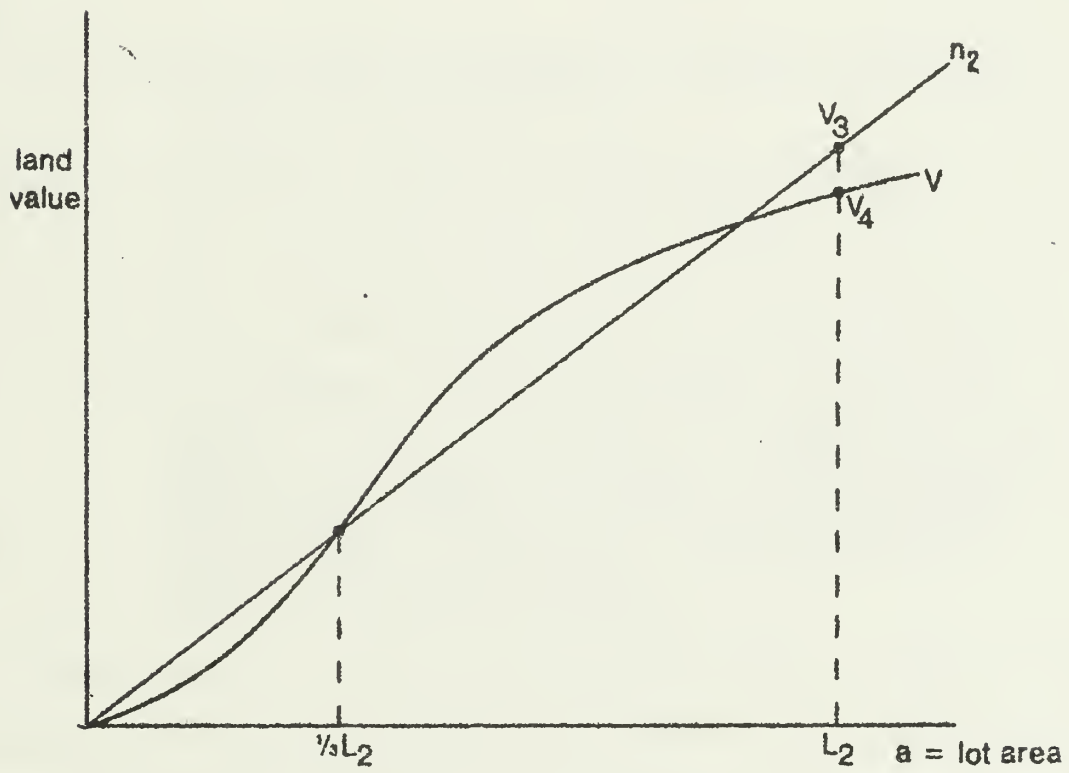


Figure 2

of time. That is, there is a constant rate of appreciation in land value. The Richardson, et. al., study (1974) used a linear specification of the value-time relationship in a similar context. This, of course, assumes that value grows by a constant amount each period. Since inflation was a primary cause of the appreciation in land values in the sample used in this paper, the exponential specification seems superior.

3. The Model

In order to test these hypotheses, the following model was developed:

$$(1) \quad V_1 = \delta_0 \exp[\beta_1 m_1 + \beta_2 t_1 + \beta_3 (a_1 - s)^{1/3}]$$

where

V_1 = the market value in thousands of dollars of lot 1 as evidenced by an actual sale;

m_1 = the distance of the lot in miles from the CBD;

t_1 = the year of the sale where 1969 = 1 and $t = 1, 7$;

a_1 = the area of the lot in thousands of square feet; and

s = a shift parameter. As area approaches s , the first derivative of V_1 with respect to a_1 approaches infinity. Thus, s is the point at which the value-area function ceases to increase at an increasing rate and begins increasing at a decreasing rate. If s were equal to zero, the model would only be capable of detecting plattage.

In order to fit a function approximating these in Figures 1 and 2, an inverse cubic function appropriately shifted to the right by the s parameter was used.⁵ The model was estimated by taking the natural logarithms of both sides of equation (1) and utilizing ordinary least squares. Regressions were run for s equal to the integers from 5 to 25,

and the reported magnitude of s was selected so as to maximize the proportion of total variation in value which is explained by the regression. The data consist of a sample of 26 lot sales in Champaign, Illinois. The sales were during the period 1969 to 1975.

The results were as follows:

$$(2) \quad \ln V_1 = 2.467 - .044m_1 + .1558t_1 + .1588(a_1 - 15)^{1/3}.$$

(.506) (.009) (.0873) (.082)

All coefficients are significantly different from zero at the 90% level of confidence, all signs are as expected, and the adjusted coefficient of determination is .647. The land value gradient is .044, and the annual rate of appreciation is 15.5%.

The partial value-area relationship is plotted in Figure 3 over the range of lot area in the sample (i.e., 5.5 to 25.5 thousand square feet). Both miles from the CBD (m) and time (t) were assumed to equal unity for the purpose of constructing Figure 3. Figure 3 looks remarkably like Figures 1 and 2. Because the sample observations are distributed over the entire curve in Figure 3, plottage and plattage appear to coexist in this market. But by itself, this is not a demonstration that plottage and plattage do coexist. Since a number of functions may describe this data, only by comparing the results above with those from a model which excludes the possibility of the coexistence of plottage and plattage but which allows the value-area function to take on other appealing shapes is it possible to be quite sure that plottage and plattage coexist.

An alternative model was constructed which is capable of detecting plottage alone (i.e., $\alpha_3 > 1$ in (3) below), plattage alone (i.e., $0 < \alpha_3 < 1$),

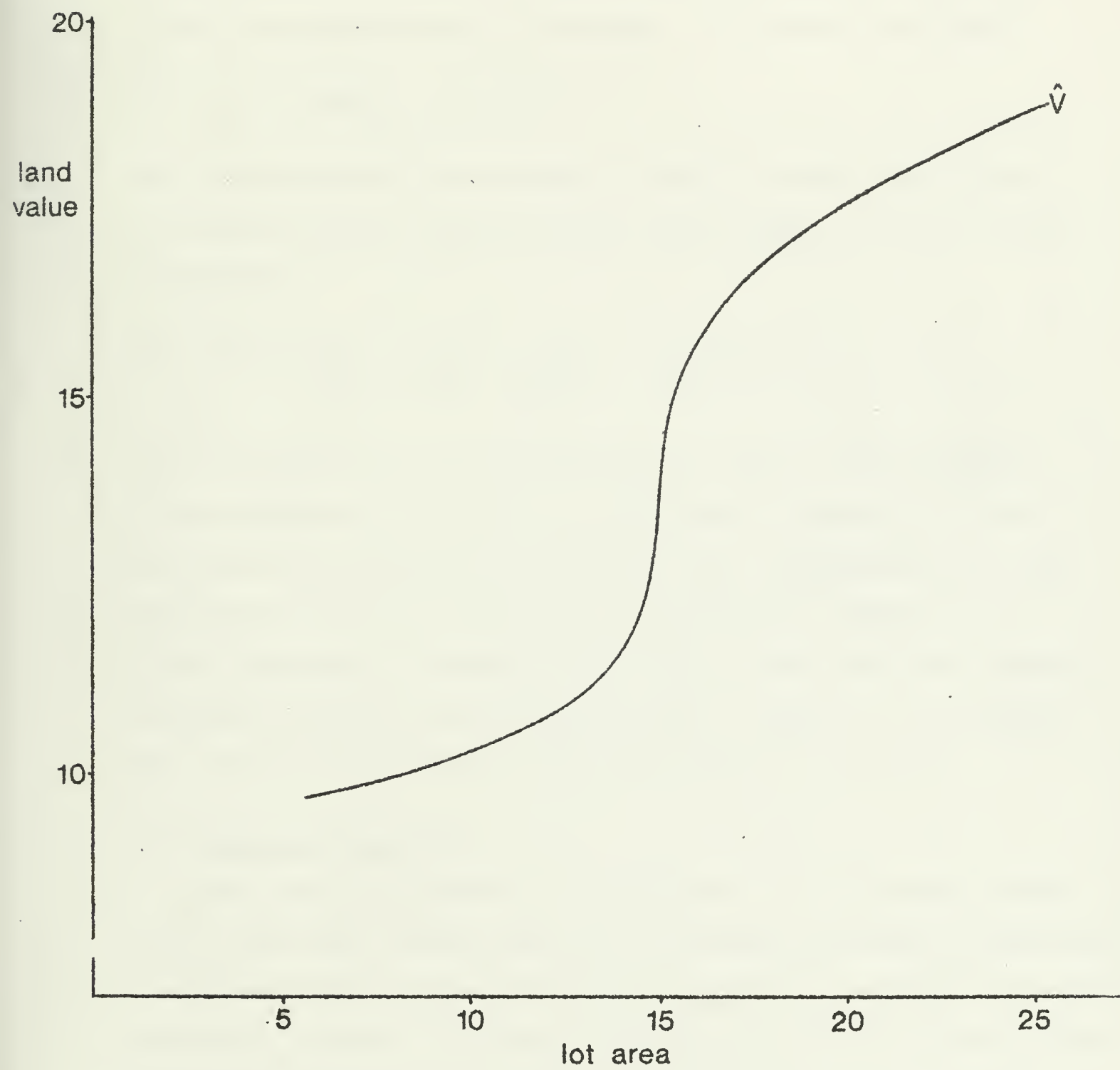


Figure 3

or a proportional relationship between market value and area (i.e., $\alpha_3 = 1$ if there is neither plottage nor plattage). This model is as follows:

$$(3) \quad V_1 = \alpha_0 \exp(\alpha_1 m_1 - \alpha_2 t_1) a_1^{\alpha_3}.$$

The alternative model was estimated by taking the natural logarithms of both sides of (3) and utilizing ordinary least squares. The results were as follows:

$$(4) \quad \ln V_1 = 8.598 - .045m_1 + .1108t_1 + .3479(\ln a_1) \quad .$$

(.959) (.010) (.0839) (.2622)

Only the constant term and the coefficient of distance from the CBD (m) differ significantly from zero at the 90% level of confidence. On the other hand, all the signs are as expected, and the magnitudes of the coefficients on time and the log of area seem reasonable.⁶ However the adjusted coefficient of determination is .618, less than that of the previous regression. Therefore this alternative model is inferior to the previous one, and the coexistence of plottage and plattage is very likely.

4. Summary and Conclusions

This paper has accomplished three purposes: 1) it formalized notions held by urban land economists about the value-area relationship by specifying a relationship which allows plottage and plattage (i.e., seemingly inconsistent notions) to co-exist; 2) it labeled the phenomenon of a value increment from subdividing land plattage, a term which may allow the concept to compete more effectively with plottage in the textbooks; and 3) it offered some empirical

evidence of the hypothesized relationships between urban land value and lot area, centrality, and time.

Land value was shown to be a negative exponential function of distance from the CBD and a positive exponential function of time. Most importantly, land value was seen to increase at an increasing rate as lot area initially increases. But as lot area continues to increase, value increased at a decreasing rate. As a result, both plottage and plattage exist. More work needs to be done on understanding costs, market imperfections, regulatory constraints and other factors which allow plottage and/or plattage to persist.

Footnotes

¹This work can be classified into those analyzing intra-urban and inter-urban variations in land values. For examples of the former, see Mills (1969); Brigham (1965); Wendt and Goldner (1967); Downing (1973); Richardson, Vipond and Furberg (1974); and Kau and Sirmans (1978). For a review of the latter literature, see Witte (1975, 1977).

²See Ratcliff (1949), p. 354, for a discussion. For a recent discussion, see Smith, Tschappat, and Racster (1977), p. 120.

³The work of Wendt and Goldner (1967) is an exception. They estimated an equation with value per square foot as the dependent variable but with area included as an explanatory variable. They found an inverse relationship which demonstrates that value increases at a decreasing rate. Richardson, Vipond and Furbey (1974) specify a linear relationship between value per unit of area and area. Although their specification is fatally flawed (e.g., value is a quadratic function of area), their results may provide a weak confirmation that value increases at a decreasing rate.

⁴Mills (1972) develops a spatial model in which rents are a negative exponential function of distance. Also see Muth (1961).

⁵See Draper and Klingman (1967) for a discussion of the cubic function. The cube root function is useful in this context, because it, like any odd root, exists for negative values of the argument.

⁶The rate of appreciation, 11%, is not too far away from that found in the previous model and is very close to what might be expected a priori. The coefficient on the log of area showing plattage, if anything, throughout the range of area is close to the same magnitude which is implicit in the work of Wendt and Goldner (1967).

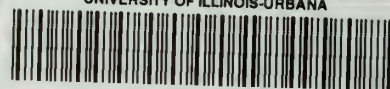
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